Popular Article

TRENDS IN AGRICULTURE SCIENCE

Vol.3 Issue 12 December 2024, Page: 2323-2329

Effect of Weather and Climate Changes on Diversity of Fisheries

Hari Prasad Mohale*[1], N. Sarang[2] and Yagnesh B. Motivarash[3]

[1,3] Teachers, Department of Fisheries Resource Management, Late Shri Punaram Nishad College of Fisheries Kawardha, Chhattisgarh, 491995

[2] Professors and HOD, Department of Fisheries Resource Management, Late Shri Punaram Nishad College of Fisheries Kawardha, Chhattisgarh, 491995

https://doi.org/10.5281/zenodo.14541511

Abstract

The impact of weather patterns and climate change on fish biodiversity, both in freshwater and marine ecosystems, is becoming increasingly evident. Changes in global temperatures, ocean acidity, sea level rise, and modified precipitation patterns are all affecting fish species' distribution, behaviour, and population dynamics. Warmer waters have caused certain species' ranges to change; warm-water species are spreading into new regions, while cold-water ones are shrinking. Extreme weather and habitat degradation (e.g., coral bleaching and mangrove loss) pose a threat to fish breeding and nursery sites, but ocean acidification affects calcifying organisms, which are vital to marine food webs. To mitigate these impacts, adaptive and ecosystem-based management strategies are essential. Key approaches include the restoration and protection of critical habitats, such as coral reefs, wetlands, and estuaries; implementation of sustainable fishing practices; and the expansion of marine protected areas (MPAs).

Introduction:

Climate and weather have a significant impact on aquaculture and other culture systems, including agriculture. Aquaculture output is significantly impacted by water temperature, which is largely controlled by weather and climate in most culture systems (Röcklinsberg, 2015). The species chosen for culture at any given location must have a temperature tolerance range that is compatible with the local climate and typical water temperature ranges. For every 10 degrees Celsius that the temperature rises, the rates of chemical reactions increase by a factor of two or three. This also holds true for the physiological mechanisms that control growth. An aquatic species would often double its growth rate within the ideal temperature range for growth in response to a 10-degree Celsius increase in that range. This means that for every degree Celsius increase, growth will increase by roughly 10%. Every species, of course, has a maximum temperature at which it will not develop; when this is reached, growth slows down (Bergqvist and Gunnarsson, 2013).

The climate in which we live is changing. Certain areas grow drier and hotter, while others flood. Huge fish kills for Filipino milkfish producers occurred in 2013 as a result of abnormally high temperatures (Ramirez *et al.*, 2019). Warm weather stresses fish and can wipe out entire stocks,

Published: 20 Dec 2024
ISSN: 2583-7850

ruining the livelihoods of farmers. But the effects are not limited to the Philippines. Globally, fish producers are aware of the rising sea levels, harsh weather, and becoming harder farming circumstances. The aquaculture industry has begun examining the effects of climate change on farmed fish more thoroughly in recent years. The conclusion is unmistakable: "The welfare of farm animals can be significantly impacted by climate change-related issues" (White *et al.*, 2018).

The length of crop that can be grown may be limited by the need to time stocking and harvesting activities during a time when the water is at an appropriate temperature. In the aquaculture of prawns, it is commonly recognised that the growth rate during the cool season is lower than that during the warm season. Consequently, it takes longer to produce a given-size prawn during the cool season compared to the warm season (Brown and Dorey, 2019). There include tropical species (penaeid shrimp, tilapia, and many more), warmwater species (ictalurid catfish, bait minnows, carps, etc.), and coldwater species (rainbow trout and other salmonids). The majority of species within each of these three types of temperature tolerance have distinct acceptable temperature ranges (Ashley, 2007).

Consequences of fisheries biodiversity: The physical and biological characteristics of freshwater and marine ecosystems are altered by weather and climate change, which has a substantial impact on fisheries. The livelihoods of communities that depend on fishing as well as fish numbers and species distributions may be impacted by these consequences. The following are some significant ways that weather and climate change affect fisheries:

1. **Water Temperature Changes**: Freshwater and ocean temperatures rise in tandem with world temperatures. Since water temperature has an impact on a fish species' growth, metabolism, reproduction, and migration patterns, fish species are sensitive to it. While cold-water species may experience habitat loss and eventual demise, warm-water species may migrate to colder places (poleward or deeper seas). Temperature variations can interfere with prey availability and breeding cycles, which lowers fish survival rates.
2. **Ocean Acidification**: Ocean acidification results from CO_2 being absorbed by the sea. As a result, the pH of the sea is lowered, which has an impact on plankton, corals, and shellfish—organisms that are the foundation of many marine food webs. Acidification can damage calcifying organisms (such as clams and oysters), making it harder for them to build shells. This impacts both the general biodiversity and the availability of prey for fish.
3. **Changes in Ocean Currents and Upwelling:** Ocean currents and upwelling, which carry nutrients to the surface, can be altered by climate change. Because upwelling zones contain a lot of nutrients, they provide excellent fishing locations. Disruptions can have a detrimental effect on fish and plankton supplies by reducing the availability of nutrients.

Published: 20 Dec 2024
ISSN: 2583-7850

4. **Storms and Extreme Weather Events:** Storms (such as hurricanes and typhoons) are predicted to become more frequent and intense due to climate change, potentially causing damage to fishing infrastructure (such as boats and ports) and upsetting fish populations. Coastal ecosystems that are vital fish nurseries, such as seagrass beds, mangroves, and coral reefs, can be destroyed by storms. Fisheries can be disrupted by extreme weather events that lead to permanent or temporary fluctuations in fish populations.
5. **Changes in Precipitation and River Flows**: Changes in precipitation due to climate change might cause droughts or floods. Freshwater fisheries, particularly those in rivers and lakes, may be impacted by these changes. Droughts can cause rivers to flow less, which can raise water temperatures and lower oxygen levels—both of which are bad for fish. On the other hand, fish spawning grounds and habitats can be changed by severe rainfall and flooding. Changes in river flows might make it more difficult for fishlike salmon to migrate, as they need certain water flow characteristics to get to their spawning grounds.
6. **Sea-Level Rise**: Coastal environments that are vital to many fish species at different phases of their lives, like salt marshes, mangroves, and estuaries, may be submerged by rising sea levels. Sea level rise has the potential to impact freshwater and brackish water species by raising the salinity of coastal areas and estuaries.
7. **Impact on Fisheries-Dependent Communities**: For millions of people, fish stocks are a vital source of food and income. The availability and production of fish are impacted by climate change, which poses a threat to fishing communities' livelihoods, particularly in developing countries. The world's food supply may be impacted by declining fish populations, especially in areas where fish is the main source of protein.
8. **Shifts in Fish Diseases and Parasites:** Fish populations may be more susceptible to parasites and illnesses that are more common in warmer waters. Fish survival is decreased as a result, and commercial aquaculture operations may suffer as well. Water quality changes may encourage invasive species, which have the ability to displace native fish and upset regional ecosystems.

Effect on fish and fisheries:

Fish number in the billions, despite all these changes. Certain ranges of water temperature are ideal for each species. Fish experience allostatic overload, or continuous stress, if temperature fluctuations consistently fall outside of their acceptable range. Energy is needed to fight stress, thus fish will consume extra to make up for their lost energy. Without this additional strain, 25–85% of production costs already come from feed. In addition to stressing the fish, increased hunger forces farmers to spend more on feed (Weis, 2007). Suppressed immunological function is another adverse impact of elevated stress. When was the last time you were working on a demanding project? It's possible that your body responded to low sleep and high cortisol (the stress hormone) by making you

Official Website: trendsinagriculturescience.com
e-mail Address: trendsinagriculturescience@gmail.com
Published: 20 Dec 2024
ISSN: 2583-7850

sick with a cold. Fish are not any different. Their immune systems can only withstand so much stress before they start to deteriorate. They eventually become more susceptible to illnesses and parasites that they may have normally fought off (Cable *et al.,* 2017). The primary obstacle posed by climate change is the increased frequency and severity of disease and parasite outbreaks. And higher antibiotic use is typically the response to more illness. Producers of salmon in Chile currently use nearly ten times as much antibiotics on their fish than they do on hens. Antibiotic resistance in humans and fish can result from high antibiotic doses; this is a worrying side-effect of global warming in aquaculture.

Management Prospects for Mitigating the Effects of Weather and Climate Changes on Fish Biodiversity

Ecosystem resilience and fish population protection depend heavily on sustainable management strategies, as weather and climate change continue to impact fish biodiversity. In aquatic habitats, effective management techniques can reduce adverse effects, encourage adaptation, and preserve biodiversity. Here are a few important managerial opportunities:

1. Adaptive Fisheries Management:

a. **Ecosystem-based management (EBM):** When managing fisheries, EBM adopts a holistic approach that takes into account the entire ecosystem, including changes in the environment and human activity. Fisheries management that adapts dynamically to the changing climate can be aided by this tactic.

b. **Flexible quotas and regulations:** In order to minimise overfishing and lessen the strain on endangered species, adaptive quotas and fishing seasons based on real-time environmental data (such as water temperature and fish migrations) can be implemented. Managers of fisheries should modify catch limits in response to changes in the environment and the health of fish stocks.

c. **Monitoring and forecasting:** Changes in fish stocks and ecosystem dynamics can be predicted with the aid of climate models and oceanographic data, which can also be used to predict changes in species distribution and abundance. Making well-informed decisions requires continuous monitoring of environmental conditions and fish populations.

2. Habitat Restoration and Protection:

a. Restoring critical habitats: It is essential to preserve and restore freshwater and coastal ecosystems, including wetlands, seagrass beds, mangroves, and coral reefs. Many fish species use these environments as their feeding grounds and nursery. Fish populations can become more resilient to the effects of climate change through habitat restoration.

b. Marine protected areas (MPAs): Fish populations can find refuge in MPAs, which can help them recover from the stresses of overfishing and climate change. Additionally, MPAs can act as buffer zones, preventing human activity in sensitive areas and preserving biodiversity.

Published: 20 Dec 2024
ISSN: 2583-7850

c. **Riparian zone management:** Maintaining the health of riparian zones the area of land around rivers and streams can lessen the effects of droughts, floods, and temperature fluctuations on freshwater fish species.

3. Reducing Other Stressors on Fish Populations:

a. **Addressing overfishing:** Fisheries populations and ecosystems are weakened by overfishing, which intensifies the consequences of climate change. The implementation of legislation, surveillance, and international collaboration to enforce sustainable fishing methods might alleviate pressure on species that are susceptible to climate change and enhance their ability to withstand it.

b. **Pollution control:** Mitigating pollutants originating from industrial waste, plastic trash, and agricultural runoff can enhance water quality and alleviate stress on fish populations. Ecosystems in good health are better able to withstand the effects of climate change.

c. **Invasive species management:** The growth of invasive species, which can upset regional ecosystems and displace native fish, can be aided by climate change. Protecting biodiversity requires invasive species control strategies to be put into place, including monitoring and eradication initiatives.

4. Strengthening Aquaculture Practices**

a. **Sustainable aquaculture:** Aquaculture that is robust to climate change can be crucial in maintaining food security and relieving pressure on wild fish stocks. The adoption of native species and other sustainable methods like polyculture and integrated aquaculture can help lessen the negative effects of climate change on fisheries.

b. **Improved breeding programs:** Aquaculture may be supported and biodiversity increased by creating and breeding fish species that are more tolerant to changes brought about by climate change, such as temperature swings and ocean acidification.

c. **Minimizing disease risks:** Enhancing biosecurity protocols in aquaculture facilities can lower the likelihood of disease outbreaks and restrict the spread of illnesses to wild populations, since rising temperatures can make fish diseases more common.

5. Enhancing International and Regional Cooperation:

a. **Transboundary fisheries management:** Fish do not adhere to national boundaries, especially as they migrate in response to changing environmental conditions. International cooperation is essential for managing transboundary fish stocks, particularly in shared ecosystems like oceans, seas, and rivers.

b. **Global climate agreements**: Protecting biodiversity can be given priority when fisheries management is incorporated into international climate agreements, like the Paris Agreement.

Official Website: trendsinagriculturescience.com
e-mail Address: trendsinagriculturescience@gmail.com
Published: 20 Dec 2024
ISSN: 2583-7850

Mechanisms for climate finance can help developing nations strengthen the resilience of their coastal communities and fisheries.

c. **Shared data and research:** In order to exchange information, studies, and best practices about fisheries management and climate change, nations and regions should work together. Cooperation can be greatly enhanced via global institutions and regional fisheries management organisations (RFMOs).

6. Promoting Ecosystem Resilience:

a. **Biodiversity conservation:** Resilience to environmental changes is improved in ecosystems through the preservation and enhancement of biodiversity. Ecosystems with greater diversity are better able to rebound from climate-related shocks including storms, temperature fluctuations, and acidification.

b. **Promoting connectivity:** Connectivity across habitats is essential for allowing species to migrate and adapt to changes in their environment. Examples of this include river corridors and marine migration pathways. In order to facilitate species migration, protected corridors and integrated landscape approaches are essential.

c. **Resilience-focused management:** Long-term fisheries sustainability can be achieved by giving priority to species and habitats that are more tolerant of climate change. It is advisable for managers to concentrate on ecosystems that possess a greater innate ability to adapt, including deep-water habitats or areas with minimal human influence.

Conclusion

The effect of weather and climate changes on fisheries is multifaceted and varies by region. Adaptation measures, such as improving fisheries management, restoring habitats, and monitoring ecosystem changes, are essential for sustaining fish populations and the communities that depend on them in the face of ongoing climate change**.** An all-encompassing, flexible, and multi-scale strategy is needed to manage the effects of weather and climate change on fish biodiversity. Fisheries can adapt to climate change by repairing habitats, enacting sustainable fishing methods, safeguarding marine ecosystems, and involving local populations. By preserving fish populations and the ecosystems they depend on for future generations, effective management will support food security and biodiversity.

References:

Ashley, P.J., 2007. Fish welfare: current issues in aquaculture. *Applied Animal Behaviour Science*, *104*(3-4), pp.199-235.

Bergqvist, J. and Gunnarsson, S., 2013. Finfish aquaculture: Animal welfare, the environment, and ethical implications. *Journal of agricultural and environmental ethics*, *26*, pp.75-99.

Brown, C. and Dorey, C., 2019. Pain and emotion in fishes–fish welfare implications for fisheries and aquaculture. *Animal Studies Journal*, *8*(2), pp.175-201.

Cable, J., Barber, I., Boag, B., Ellison, A.R., Morgan, E.R., Murray, K., Pascoe, E.L., Sait, S.M., Wilson, A.J. and Booth, M., 2017. Global change, parasite transmission and disease

Published: 20 Dec 2024
ISSN: 2583-7850

control: lessons from ecology. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1719), p.20160088.

Dubey, S.K., Trivedi, R.K., Chand, B.K., Mandal, B. and Rout, S.K., 2017. Farmers' perceptions of climate change, impacts on freshwater aquaculture and adaptation strategies in climatic change hotspots: A case of the Indian Sundarban delta. *Environmental Development*, *21*, pp.38-51.

Huntingford, F.A., Adams, C., Braithwaite, V.A., Kadri, S., Pottinger, T.G., Sandøe, P. and Turnbull, J.F., 2006. Current issues in fish welfare. *Journal of fish biology*, *68*(2), pp.332-372.

Jeppesen, E., Mehner, T., Winfield, I.J., Kangur, K., Sarvala, J., Gerdeaux, D., Rask, M., Malmquist, H.J., Holmgren, K., Volta, P. and Romo, S., 2012. Impacts of climate warming on the long-term dynamics of key fish species in 24 European lakes. *Hydrobiologia*, *694*, pp.1-39.

Mahmoud, A.E.A., 2015. Effect of Different Management of Fish Ponds on Fish Productivity and Water Quality. *Benha University*.

Ramirez, P.J.B., Lansangan, E.V., Tubal, J.J.M. and Catelo, S.P., 2019. Impacts of Extreme Temperature on the Tilapia Value Chain from Pond Culture in Luzon, Philippines. *Journal of Economics, Management & Agricultural Development*, *5*(1), pp.23-36.

Röcklinsberg, H., 2015. Fish consumption: choices in the intersection of public concern, fish welfare, food security, human health and climate change. *Journal of Agricultural and Environmental Ethics*, *28*, pp.533-551.

Weis, A.J., 2007. *The global food economy: The battle for the future of farming*. Zed Books.

White, P.G., Shipton, T.A., Bueno, P.B. and Hasan, M.R., 2018. Better management practices for feed production and management of Nile tilapia and milkfish in the Philippines. *FAO Fisheries and Aquaculture Technical Paper*, (614), pp.I-79.

Published: 20 Dec 2024
ISSN: 2583-7850